Status of Offline Software for Pixel Cosmic Test

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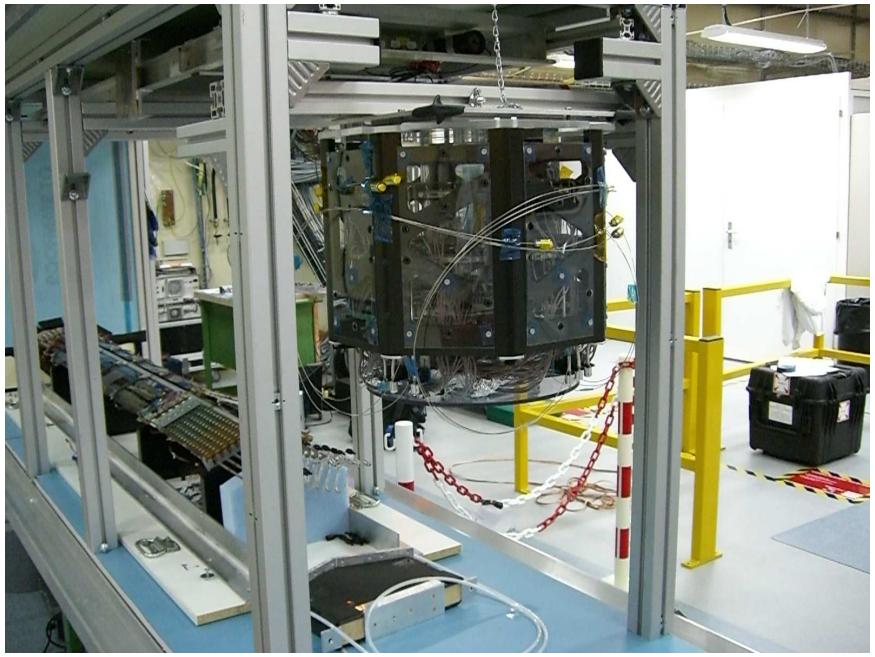
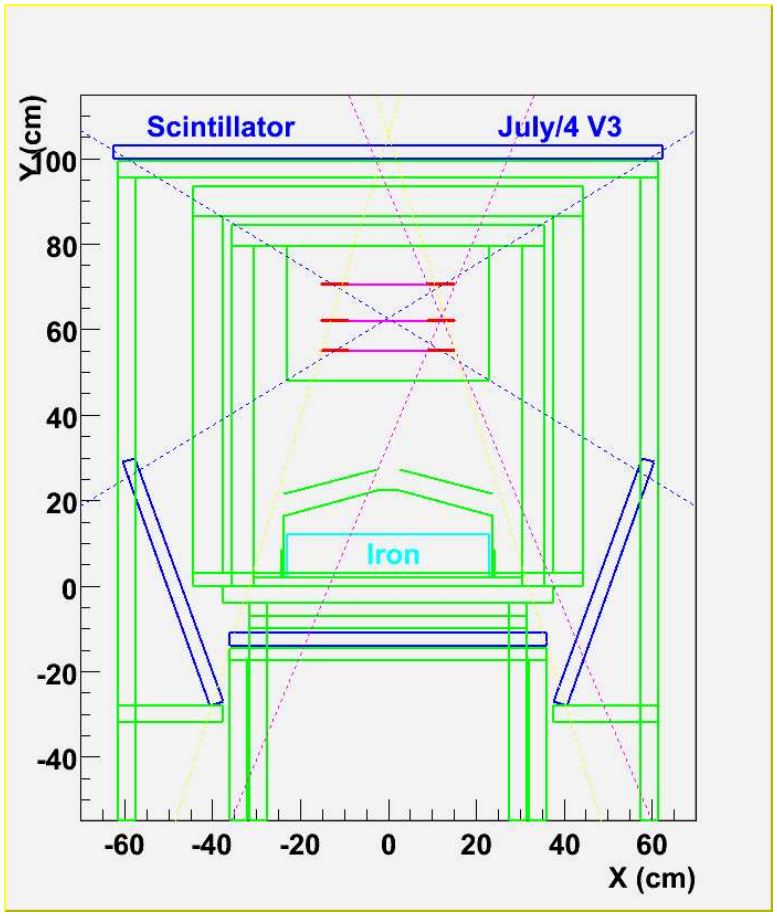
- Introduction
- Setup at SR1
- Prototype of Pixel Calibration Offline DB
- Simulation Setup
- Cosmic Reconstruction
- Performances Studies
- Conclusion

Introduction

- 10% system test with full read out chain
- Develop infrastructure and operational procedures
  - Connectivity and data flow
  - Calibration
  - Simulation
  - Reconstructions
- Finding and problem solving before real data taking
- Learn about detector performance first hand ...

Hardware Setup at SR1



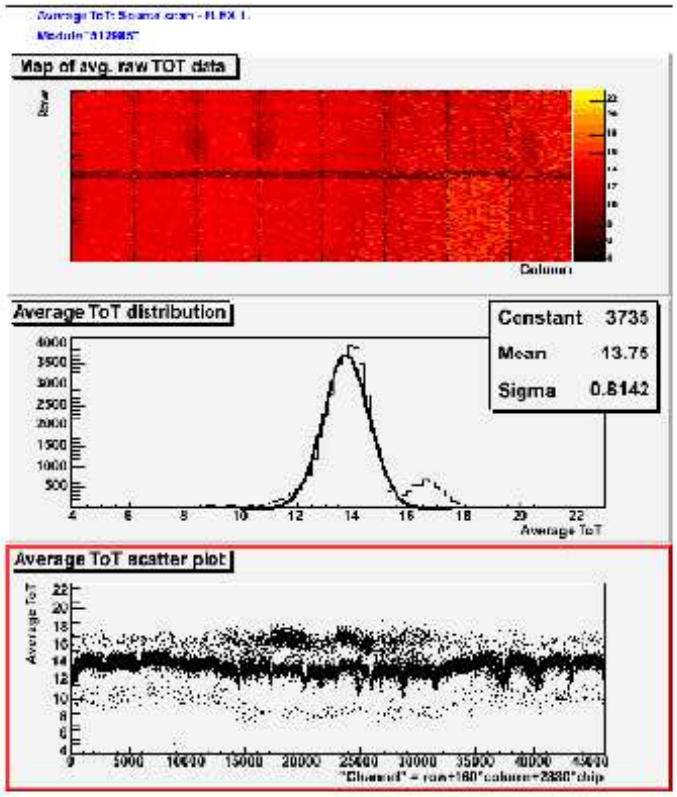


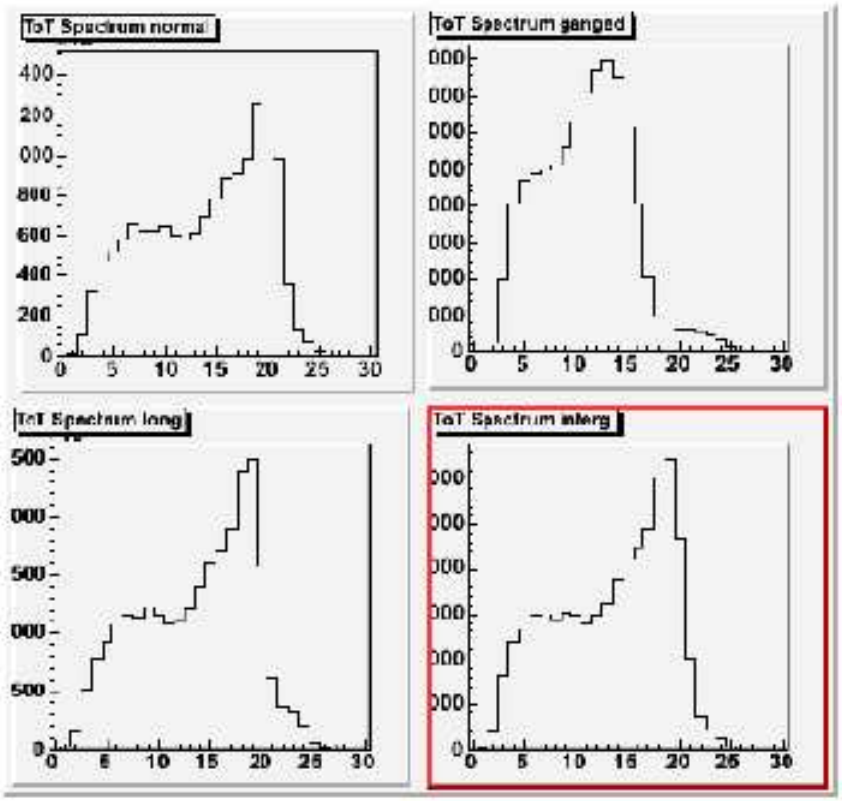
- Small SLAC scintillator on top and bottom and large ones on sides
- Requiring coincidences top and bottom (S1) or any two of four (S6)

Calibration

- The calibration data is stored in the database with defined format and its Interval of Validity (IOV)
- A tool/service is used to access the data via COOL API
- Data consists of:
  - Threshold, sigma, noise, Time walk or in-time threshold
  - Time over Threshold conversion (ToT = A + B/(Q+C), σ=P1+P2 $\cdot$ ToT)
  - ChannelStatus, but not covered here
- Payload will be CLOB containing constants for each chip
- Defining Objects in Transient Detector Store (TDS) and Interfacing with offline
- Some technique issues
  - Is the granularity of calibration at module, chip or pixel ?
  - What to store with what precision and how fast to accesses required from offline.

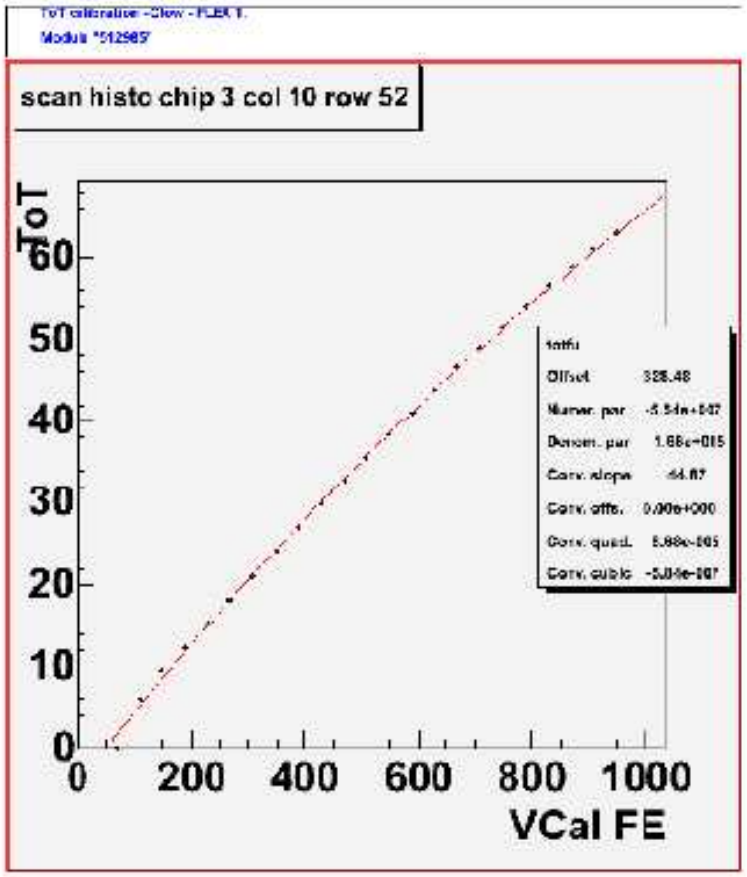
Threshold Uniformity from PDB (Attilio)





- The uniformity seems flat within the chip, not the module
- Need to treat normal, long, ganged pixel differently

Charge Vs TOT Conversion (Attilio)



- How's the best parametrization ?
- Sensitive to radiation damage and make sure data have precision

Data Model

Storage	Definition	Unites	Typical range
1B	threshold	30e	2000-5000 e
1B	dispersion	3e	80 - 600 e
1B	noise	3e	0 - 600 e
1B	timewalk	30e	2000-8000 e
float	A for ToT		0-300
float	B for ToT		
float	C for ToT		
1B	P1 dispersion of ToT	1/100	+-100
1B	P2 dispersion of ToT	1/1000	+-100

- 38B/per chip, corresponding to 1 MB/Detector
- Can afford extra few bytes to have more precision if needed

Object Class in TDS and PixelCalibDbTool

- Create PixelChipSummaryData to hold all the data for a chip
- Store PixelCalibData per module in storegate and persistified using COOL.
- All access is provided in the AlgTool – PixelCalibDbTool
- Call a get/set method with the name of the desired quantity passing the identifier of detector elements.
- Methods are also provided for bulk transfer of constants between text file and IOV database.
- Preparing Pixel Calibration data for cosmic test
- Provide interface with offline packages

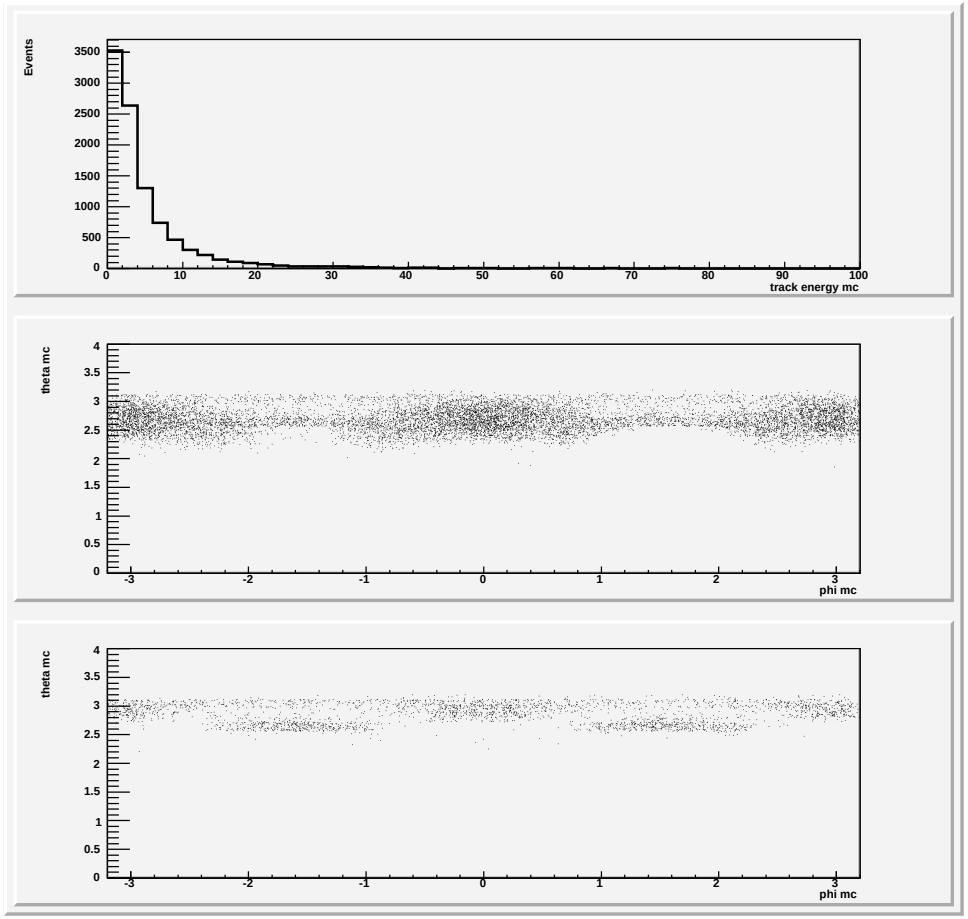
Pixel EndCap Setup and Trigger Simulation (Marian)

- Updated the scintillator and endcap geometry recently
- Need few packages from head with Atlas offline software (12.0.0 to 12.2.0)
  - InnerDetector/InDetExample/InDetCosmicSimExample
  - Generators/CosmicGenerator
  - InnerDetector/InDetDetDescr/PixelGeoModel
  - Simulation/G4Atlas/G4AtlasApps
  - Simulation/G4Atlas/G4AtlasControl
  - Simulation/G4Sim/FADS/FadsVisualization
  - InnerDetector/InDetCosmics/InDetCosmicSimAlgs
  - InnerDetector/InDetDigitization/PixelDigitization
- Wiki at https://twiki.cern.ch/twiki/bin/view/Atlas/HowToRunPixelEndCapCCosmicSimulatio

Cosmic Event Simulation (Marian)

- Simulation is run from InDetCosmicSimExample from the head
- InDetCosmicEndCapSim_topOptions.py
  - CosmicGenerator ($1 < \theta < 3.14$, $-\pi < \phi < \pi$)
  - G4AtlasApps
  - Pixel and scillator G4hits
  - InDetCosmicTrigger
  - G4Hits pool file
- InDetCosmicDigtopOptions.py
  - Digitization with the latest tuning (Fridrik)
  - The noise level has changed from 10^{-5} to 10^{-8} with realistic charge deposition model
  - Pixel RDO digi pool file

Cosmic Distributions



- phi vs theta of cosmic after trigger seems funny (Top: E, Mid: S6, Bot: S1)
- The trigger efficiency is 10.7(2.7) % for S6(S1)

Cosmic Reconstruction

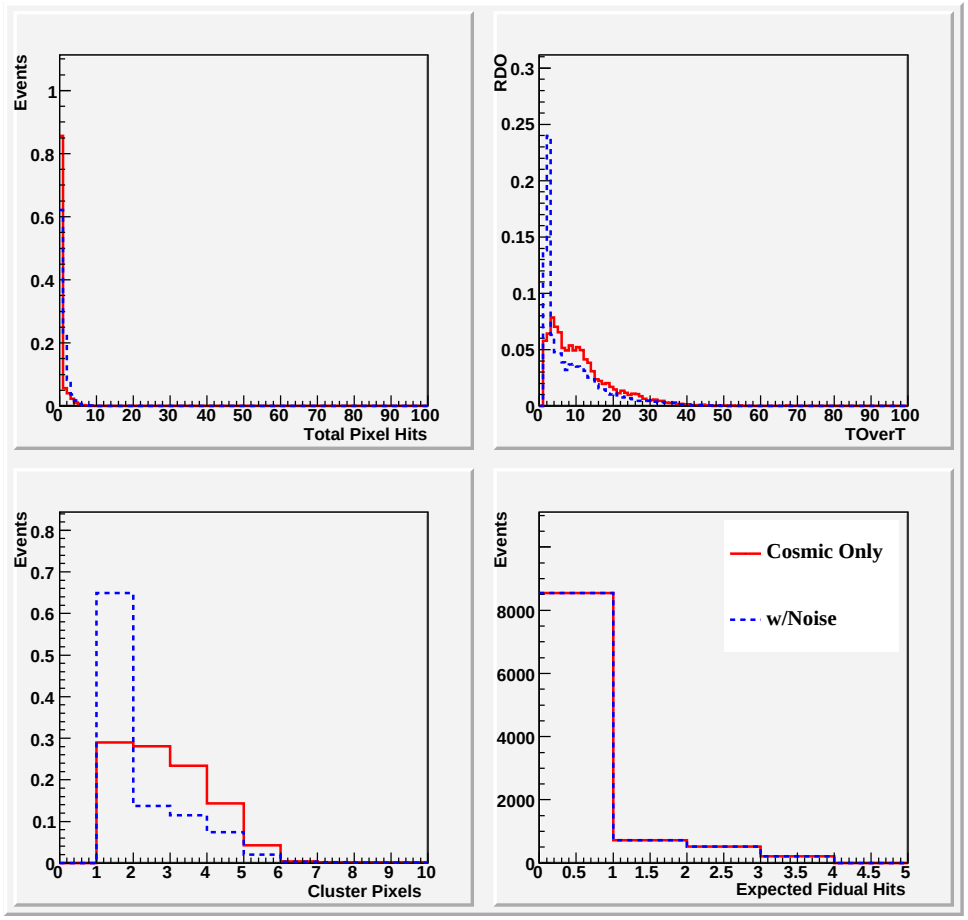
- Use release 12.0.0 plus the fixes for Pixel Endcap cosmic simulation from Marian

- Took advantags of the existing software for CTB tracking and modified few packages for pixel tracking:
  - InDetCosmicRecExample
  - SiCTBTracking
  - TrkGlobalChi2Fitter

- Tracking strategies are simple:
  - Finding 3-hits track from three separate disk first
  - Search for overlap hits from the neighbor modules from each disk
  - Do a line fit in x-z and y-z with $\chi^2 < 25/\text{dof}$
  - Do SiCTBAmbSolver and choose the best candidates

- Wiki at https://uimon.cern.ch/twiki/bin/view/Atlas/HowToRunPixelEndCapCCosmicReconst

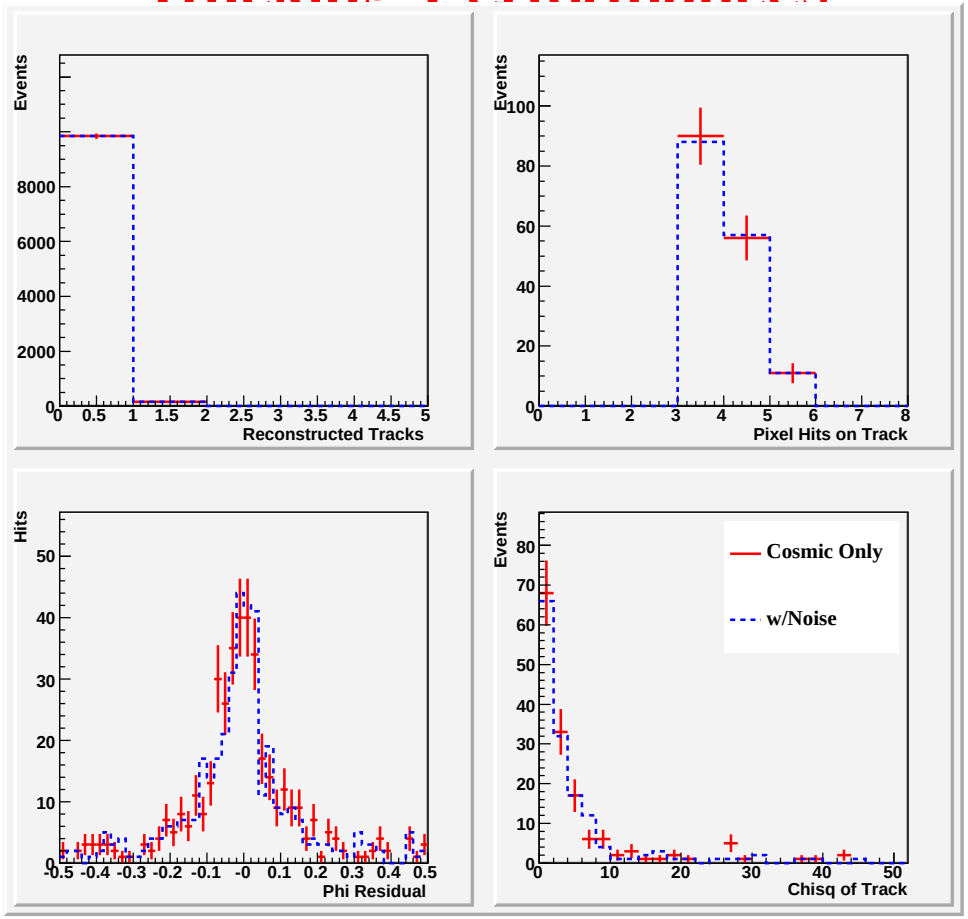
Pixel Occupancies and ToverT



- The noise is much reduced in new digitization and TOT of RDO seems much lower.

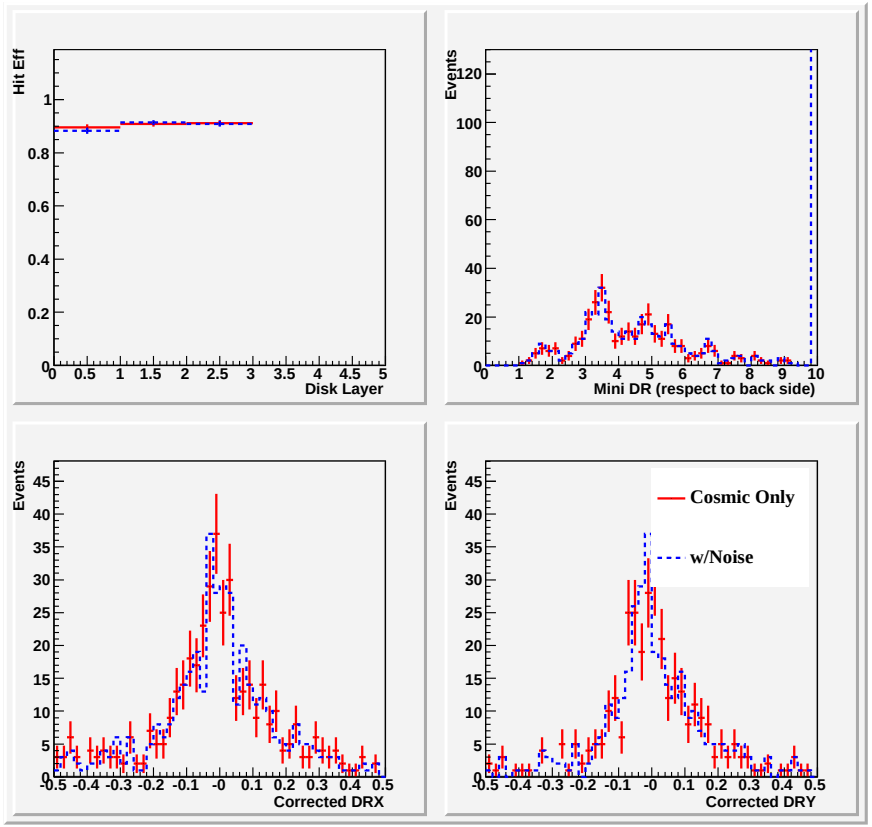
- The fiducial hit per disk is defined $89 < r < 150$ mm respect to center of disk.

Tracking Performances



- The tracking efficiency (≥ 3 hits)is low 1.5%.
- Tracking efficiency for 3 fiducial hits track is $75 \pm 3\%$ (≈90% of disk hit eff)
- The impact of noise is negligible with the current noise level.

Overlap Hits, Resolutions, and Trigger Eff.



- Hit efficiency per fiducial disk hits is about 90% (overlap about 18%)
- The overlap resolution seems about 100 μm with prefect angle resolution

Trigger configurations	trigger Eff	Tracking Eff	Tot Eff
Top & bottom (S1)	2.7%	1.5%	0.04%
Any two of 4 (S6)	10.7%	1.5%	0.15%

Conclusion

- The software of calibration, simulation, digitization, and reconstruction seems work for pixel endcap.
- Usefulness of cosmic test depends on the noise level
- The disk hit efficiency per fiducial hits ($89 < r < 150$ mm) is about 90% with overlap 18%.
- Tracking efficiency with 3 disk hits is $(75 \pm 3)\%$
- Expect 5000 reconstructed tracks with 24 hours running assuming the trigger rate of 5 Hz
- On average you need at least 100 overlap hits per module or total 13K tracks for first rough alignment studies ($< 10\mu m$)
- Will learn alot about system test, detector performance, and alignment.